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May 20, 1994

BY HAND DELIVERY

Mr. William F. Caton
Acting Secretary
Federal Communications Commission
1919 M Street, N.W. Room 222
Washington, DC 20554

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MAY 20 1994

FEDERAL COMMUNICATIONS COMMISSION
OFFICE OF SECRETARY

RE: CC Docket No. 92-166

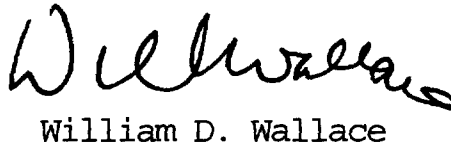
EX PARTE PRESENTATION

Dear Mr. Caton:

On May 19, 1994, Douglas Dwyre, Robert Wiedeman, Dale Gallimore Kevin Kelley, Jay Ramasastry, and William Wallace representing Loral/QUALCOMM Partnership, L.P. (LQP), met with Thomas Stanley, David Siddall, Raymond LaForge and Bruno Pattan of the Office of Engineering and Technology. Presented were issues reflected in LQP's Comments in this docket, and, particularly, issues related to potential MSS feeder link bands below 15 GHz and to MSS and GLONASS coordination as summarized in the enclosures.

Two copies of this letter and the enclosures are being submitted for inclusion in the file referenced above.

Respectfully submitted,


William D. Wallace

Enclosure

cc: (w/out enclosure)
Thomas Stanley
David Siddall
Raymond LaForge
Bruno Pattan

No. of Copies rec'd
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241

Globalstar



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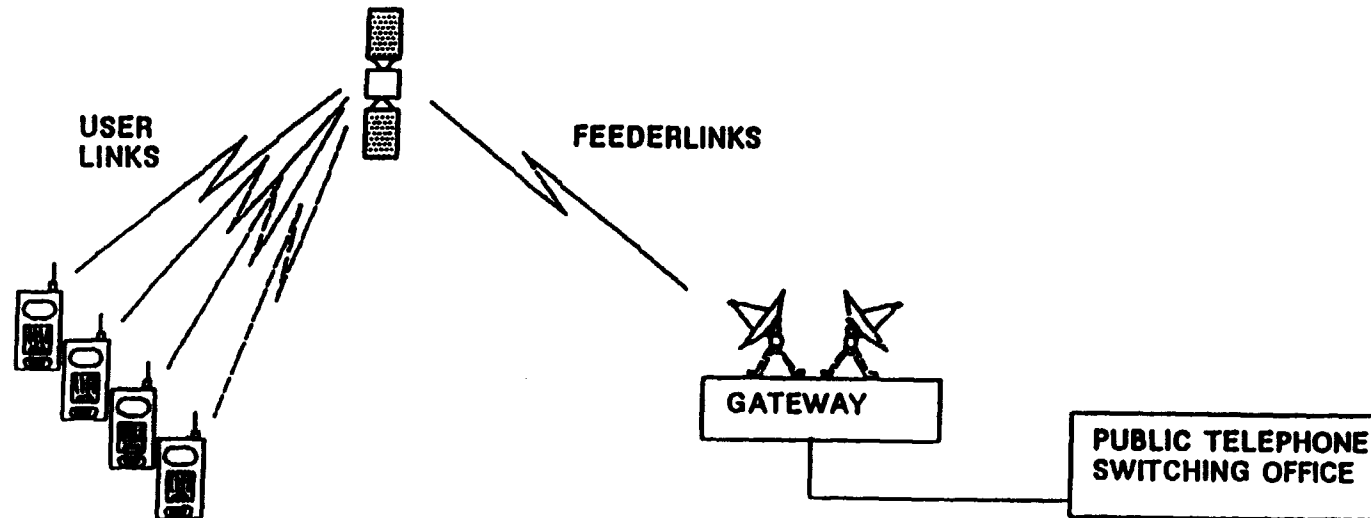
FEDERAL COMMUNICATIONS COMMISSION
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**BACKGROUND OF GLOBALSTAR AND
FEEDER LINK ISSUES**

FOR

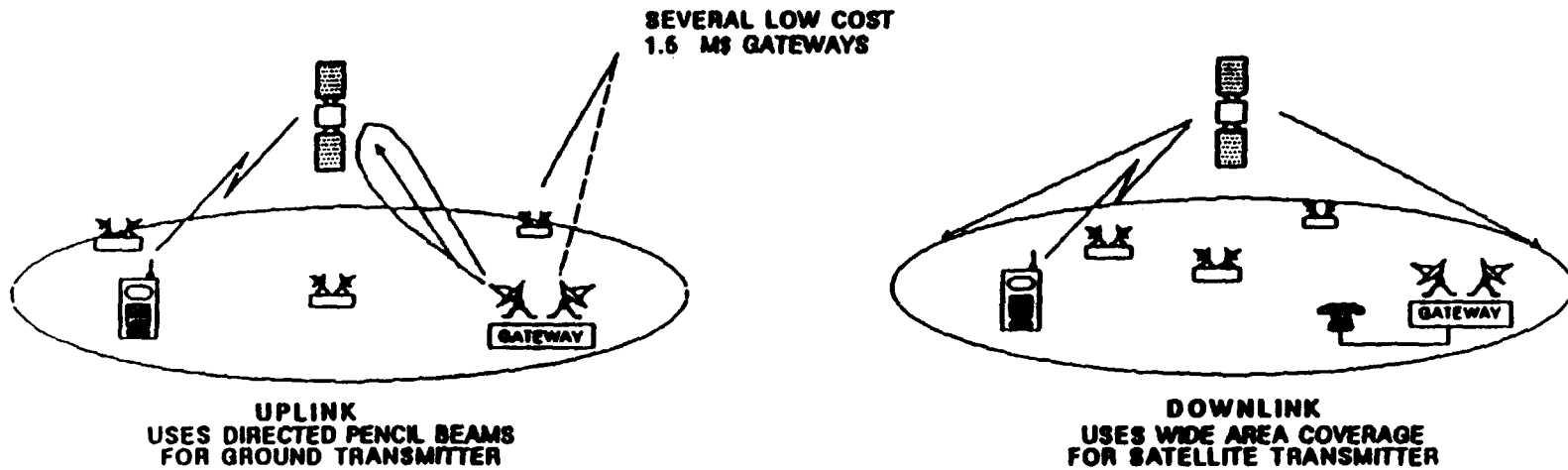
May 19, 1994 BRIEFING

Mobile Satellite Services Feeder Link Issues

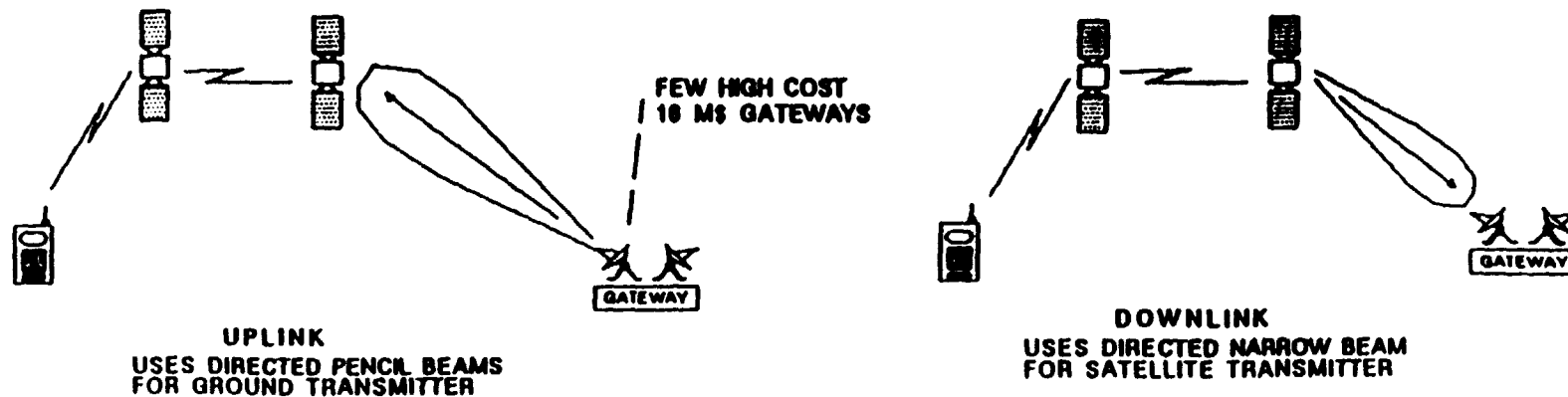


- **WARC '92 established user links but was silent on feeder links**
- **Past policy (INMARSAT, AMSC, etc) has established MSS feeder links in FSS bands**
- **WARC '95 agenda calls for allocation of MSS feeder link bands**
- **FCC has notified applicants that U.S. policy for "Big LEO" feeder links will be established prior to WARC '95 including assignment of spectrum**

MSS Feeder Links



**CONVENTIONAL REPEATER SATELLITES
REQUIRE FEEDERLINKS BELOW 15 GHz**



**INTERSATELLITE PROCESSING SATELLITES
MAY USE FEEDERLINKS ABOVE 15 GHz**

Why Feeder Links Below 15 GHz

Technical Reasons

- **Rain Attenuation above 15 GHz is severe**
- **Fades of 20 to 30 dB (factor of 100 to 1000) are common**
- **Satellite power is limited -- unable to overcome fades**
- **Larger ground antennas to compensate for fades are not practical**

Regulatory Reasons

- **There is not enough spectrum above 15 GHz to satisfy all MSS systems**
- **MSS feeder link operations in Ka-Band will preclude new Ka-Band Fixed Satellite Services such as Teledesic**
- **MSS feeder link operations in Ka-Band may preclude Local Multipoint Distribution Services (LMDS) and new Fixed Services**
- **International usage of Ka-Band Terrestrial Fixed and Fixed Satellite Services is on the increase**

Below 15 GHz Feeder Link Options



Below 7 GHz C-Band option (several band segments are available)

- Spectrum efficient reverse band sharing with FSS is required
- Sharing with terrestrial microwave users feasible
- Sharing would be required with terrestrial military use in the 4.5 - 4.8 GHz portion

Above 10 GHz Ku-Band option (several band segments are available)

- Same as below 7 GHz but no military usage
- Propagation (rain) losses 3 to 5 times more severe than C-Band

Solutions

Sharing with Fixed Satellite Service

- **Reverse Band Working (FSS Up = MSS Down)**
- **RBW eliminates interference and coordination difficulties**
- **MSS sites can be located in rural areas away from FSS sites**
- **International spectrum community agrees ITU-R progressing**

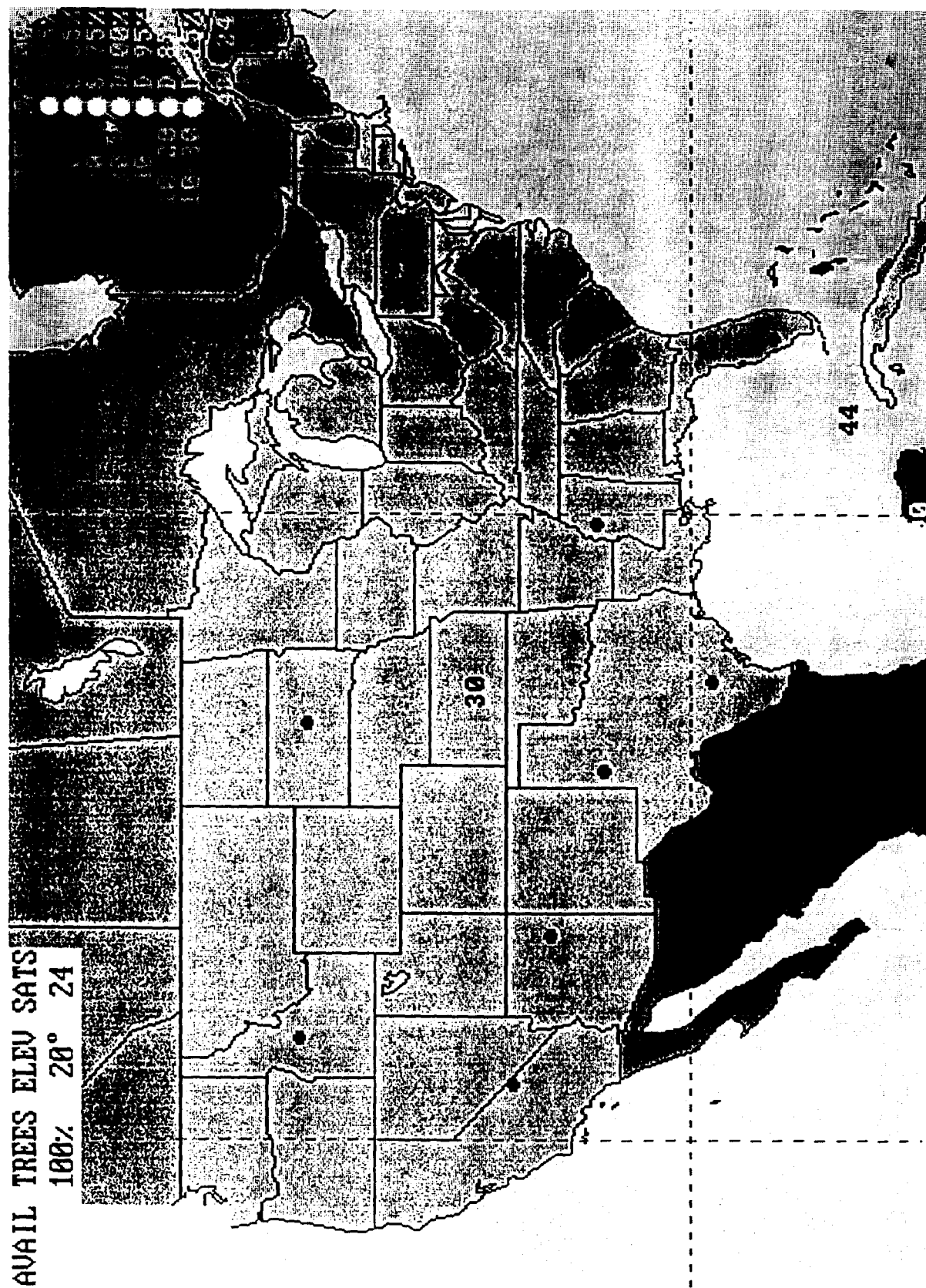
Sharing with Fixed Services (Terrestrial)

- **Downlink**
 - **Low MSS satellite signal levels are below FS interference thresholds**
 - **Two C-Band downlink band segments meet criteria**
- **Uplink**
 - **MSS sites can be located to avoid interference to terrestrial microwave sites**

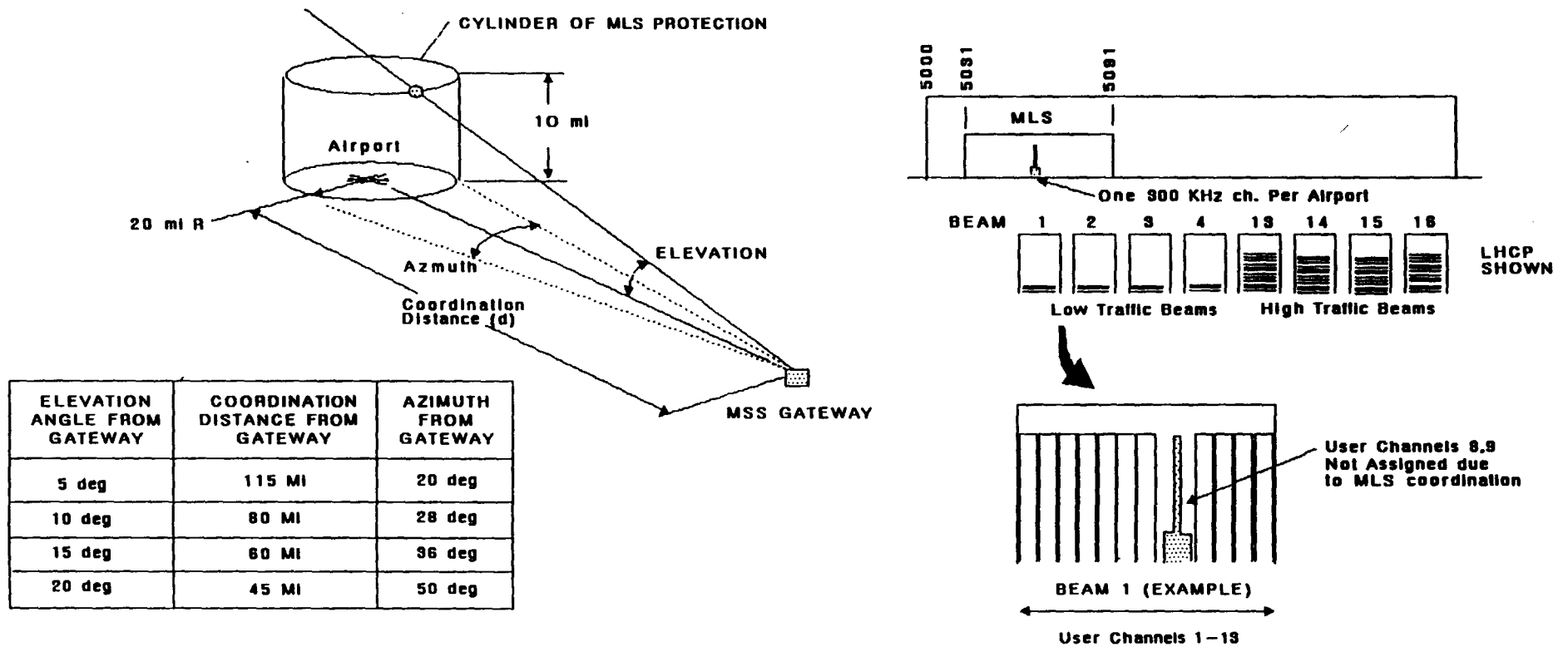
Preferred Bands

- **Globalstar requires 0.2 GHz (200 MHz) in each direction**
- **Downlink can be satisfied at C-Band**
 - **Preferred Band**
 - > > **6.875 to 7.075 GHz (Operational Fixed/Aux. Broadcast)**
 - **Alternate Band**
 - > > **6.525 to 6.875 GHz (Operational Fixed/Aux. Broadcast)**
- **Uplink can be satisfied at C-Band or Ku-Band**
 - **Preferred Band**
 - > > **5.0 to 5.25 GHz (Aeronautical Navigation)**
 - **Alternate Bands**
 - > > **4.5 to 4.8 GHz (Military)**
 - > > **10.7 to 10.95 GHz (Cellular Backhaul, Telephone)**
 - > > **11.2 to 11.45 GHz (Cellular Backhaul, Telephone)**

ILLUSTRATIVE GATEWAY SITES



5 GHz UPLINK COORDINATION



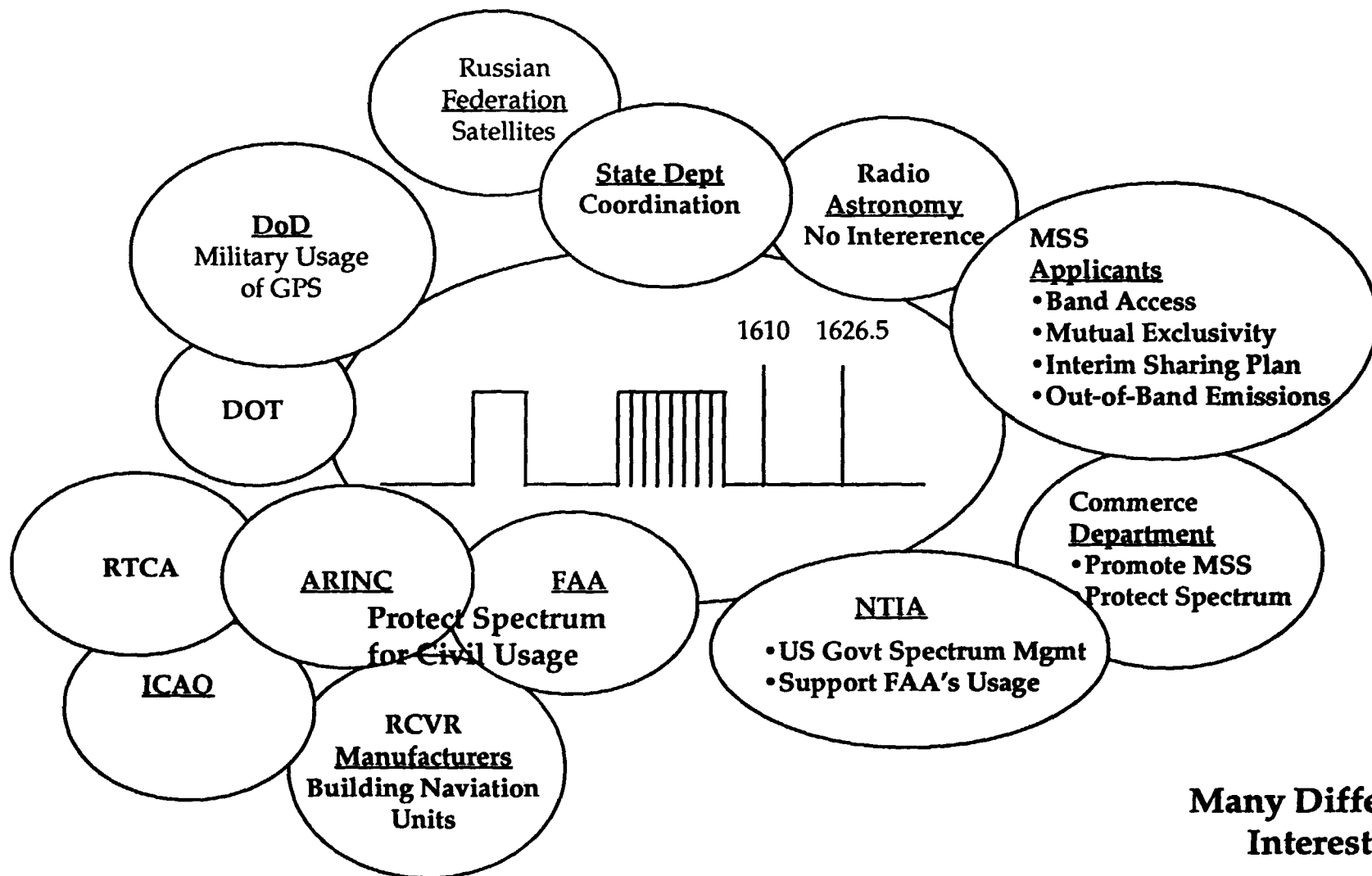
COORDINATION APPEARS FEASIBLE

- o MAIN BEAM NEVER INTERSECTS PROTECTION CYLINDER (ELEVATION ANGLE = 10 deg)
- o FEW GATEWAY SITES (ABOUT 10 NATION WIDE)
- o 664 AIRPORTS PROJECTED (160 FUNDED)
- o SITES LOCATED IN REMOTE RURAL AREAS
- o LOW TRAFFIC BEAM FREQUENCIES CAN BE ASSIGNED TO MLS BAND
- o GATEWAY CHANNEL ASSIGNMENT WITHIN BEAM CAN AVOID PARTICULAR AIRPORT ASSIGNMENT
- o DYNAMIC CHANNEL ASSIGNMENT CAN FURTHER IMPROVE EFFICIENCY
- o POTENTIAL FOR ADS, TDWR, & DIFFERENTIAL DATA LINKS ARE (TBD); PROPOSALS ARE IN OTHER BANDS

MSS AND GLONASS COORDINATION

May 1994

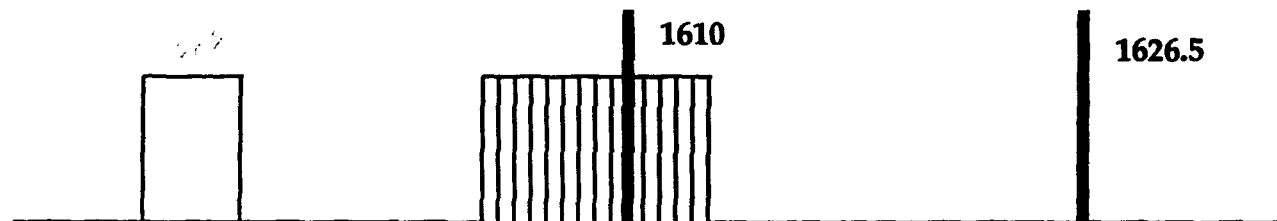
The Complexity



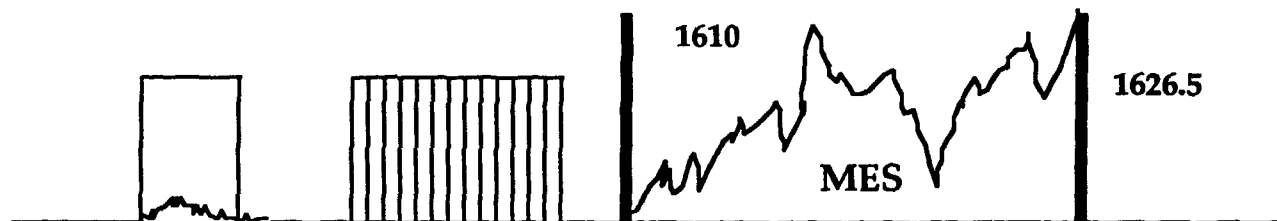
The Spectrum

DoD's View

Before

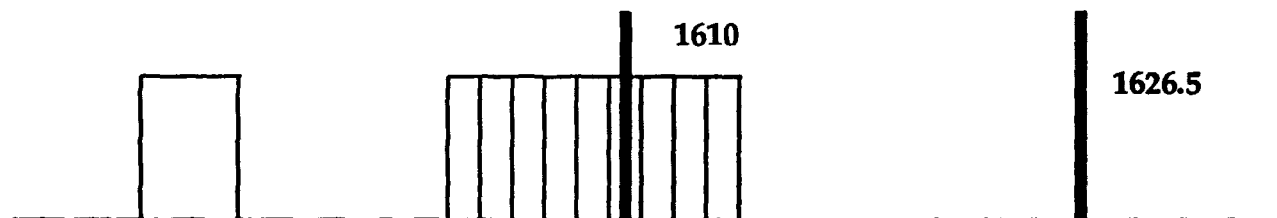


After

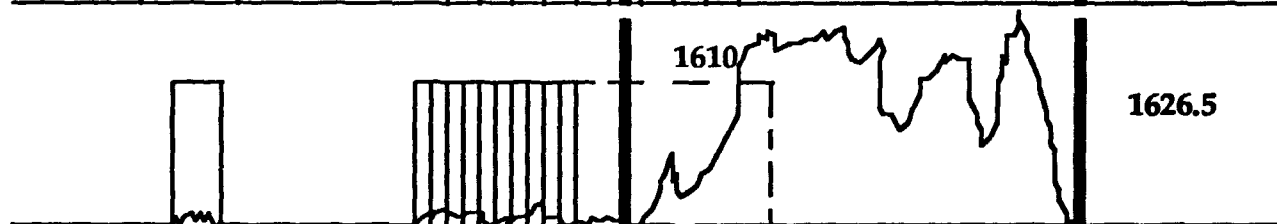


Aviation's View

Before



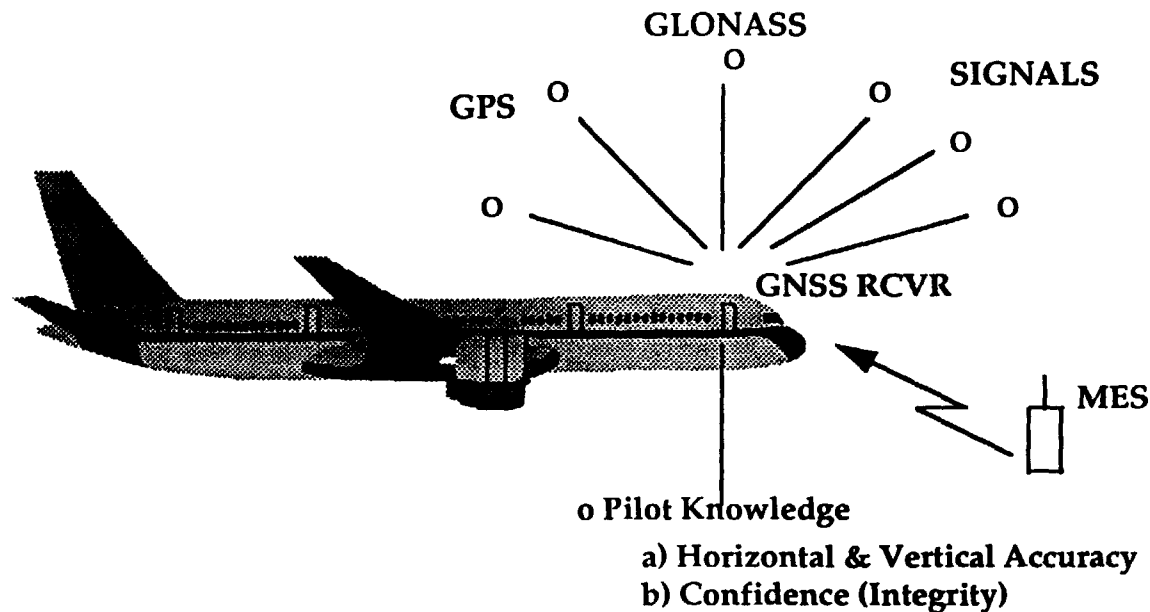
After



Position
Location

Integrity Checking

The Central Problem



Three Separate Problems

- Probability of adverse reception?
- * Operational impact if adverse reception?
- Does potential for adverse impact on a signal imply a policy imperative?

	Oceanic	Domestic	Terminal	NPA	Surface
Accuracy	12.6 nmi	1.9 nmi	1 nmi	.1 nmi	(TBD)
Availability	.99999	.99999	.99999	.99999	2 axis (TBD)
Integrity (Time to Alarm)	120 sec	60 sec	30 sec	10 sec	(TBD)

Activities

- **Independent Analysis of Technical Issues**
 - Engaged Sat-Tech Systems, Inc.; Arlington, VA
 - Survey of alternate technologies for integrity checking
- **Measurement Program**
 - Purchased 3S-Navigation GLONASS simulator
 - Purchased 3S-Navigation receiver
 - Measure impact of Globalstar ^{out of} over/band emissions on a representative GLONASS receiver
 - » At various frequency separations
 - » Signal levels to saturate front end
 - » C/I performance
 - » Measure receiver performance at several frequency cutoffs

Methodology Used by Sat-Tech

- Developed assumptions, ground rules, worst case values
- Performed probabilistic link analysis for GPS and GLONASS
- Performed signal tracking capability analysis
- Assessed operational impact of MSS induced RFI on navigation
 - Includes:
 - » Dilution of precision
 - » Receiver autonomous integrity monitoring
 - » Failure Detection and Isolation
 - Assumes:
 - » Failed GPS Satellites
 - » Failed GLONASS Satellites
 - » With and Without Barometric Aiding
 - Uses:
 - » Tens of thousands of Monte Carlo Trials
 - » Twenty thousand spatio-temporal GMO points over CONUS

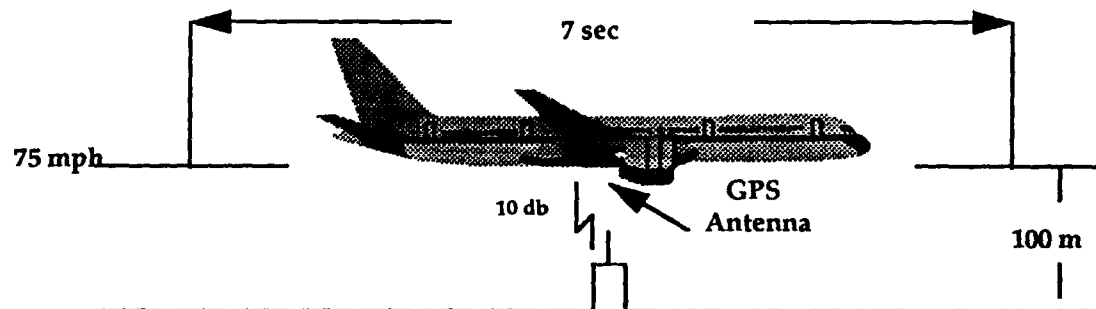
Impact Assessment for Enroute and Terminal Navigation

- **Enroute and terminal area navigation using GNSS is unaffected by MSS operations**
 - GPS is not affected at all
 - » Above 500 ft altitude, margin exists even in the worst case for an MSS unit directly under aircraft (no shielding) transmitting at max power
 - GLONASS
 - » Same as GPS above for -6, +6 frequency plan
 - » For other frequency plans
 - Some individual frequencies may experience intermittent interference above ARINC specification
 - Channels 22, 23, 24 could be affected but will not cause loss of navigation (channels are not needed)
 - » Not all GLONASS channels are required for integrity
 - All GPS signals are available
 - Evidence indicates that GPS plus 1/4 to 1/2 GLONASS constellation is required for sole means navigation
 - Barometric Aiding improves integrity even further (equiv. to 3 sat)
 - Wide Area Augmentation System (Inmarsat, etc.) (equiv. to 6 sat)
 - » GPS + WAAS + Barometric Aiding will satisfy sole means requirement

Impact Assessment for Non-Precision Approach

- **Non-precision approaches will be unaffected by MSS operations**

- Worst case outage time is less than 10 sec. time-to-alarm
- FAA 150 C-129 allows avionics to “coast” integrity after initiating approach
 - » Only four signals needed to maintain navigation



- Aircraft w/o shielding flying at 100 m above MSS unit at 75 mph
- MSS unit transmitting at max power

- Maximum degradation time 7 sec. worst case (no alarm)
- Probability of occurrence
 - » For GPS - 0.2% in CONUS
 - » For GLONASS - 5% in CONUS
- Mitigation not considered but nevertheless relevant:
 - » Blockage of MSS signal
 - » Airframe shielding
 - » Barometric Aiding further improves integrity

Impact Assessment for Surface Operations

- Current airport operations do not require nav aids, future may
- Surface operations require some form of differential overlay
 - WAAS
 - Local Area Differential
- Integrity
 - Provided by differential overlay
- System requirement for protection is order of magnitude less due to 2 axis measurement (altitude is known)
 - 2 axis measurements (altitude is known)
- Use of GLONASS is not required for surface operations
 - Availability standard less than non-precision approach
 - Availability higher due to known altitude (one satellite more)
 - Lower safety concerns, better surveillance
 - High availability of surface navigation without GLONASS
 - Robustness of GPS signal processing relative to MSS emission

Precision Approaches

- **Not discussed in the negotiated Rulemaking**
- **Category I Precision Approaches require differential overlay**
 - Wide Area Augmentation System
 - Local Area Differential System
 - GLONASS is not required
- **“New” FAA protection of GPS to ± 10 MHz center frequency**
 - Potential use of GPS “P” Code?
 - Serious technical concerns/hurdles may make such operations infeasible
- **In any case, there is no need for GLONASS Channels 22, 23 and 24 due to requirement for differential overlay**
 - Remaining GLONASS satellites are sufficient to enhance availability
- **Further out-of-band emission tests and analysis may reveal that there is no effect on Category I Approaches by MSS units**

Summary

- **A transition plan for GLONASS operations is not required**
 - Enroute, Non-Precision Approach, and Surface Operations are unaffected by MSS operations
 - Integrity checking of GNSS solutions by use of GLONASS Ch. 22, 23, 24 is not required
- **Direct maximum radiation of a MSS unit toward an unshielded GPS equipped aircraft at 500 ft will not degrade navigation**
 - Calculations performed with maximum out-of-band emissions level 18 db above level suggested by FAA NPRM Response (-92 dBw/4 kHz)
- **Protection of individual GLONASS signals is not required**
 - Due to random assignment of MSS signals and random availability of GLONASS signals near 1610 boundry
 - All GLONASS signals below 1608 are unaffected by MSS channels 2-13
 - Only 1/4 to 1/2 of GLONASS constellation is required for availability of integrity in absence of WAAS and Barometric Aiding
 - Presence of WAAS and Barometric Aiding eliminate need for GLONASS

Summary

(Continued)

- Out-of-band emissions should be limited to -74 dBw/4 kHz for MSS
- FAA NPRM Response is too conservative